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University of Utah Electromagnetic Modeling in Support of Undersea Sensor Systems

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LONG-TERM GOAL

The long term goal is to develop low frequency electromagnetic models for a) frequency domain and time domain 3-D forward prediction capabilities that include conductivity anisotropy, magnetic susceptibility, and geometric effects, b) fast imaging of surface, airborne, and borehole electromagnetic data, c) multidimensional electromagnetic inversion for airborne, surface, sea bottom and borehole EM observations.

OBJECTIVES

The objective is to improve the Navy's EM forward modeling and data interpretation capability in a cost effective manner using academic resources and leveraging industry and other agency development efforts.

APPROACH

Participate in the newly re-initiated University of Utah consortium on EM modeling and Inversion under the direction of Dr. Zhdanov. Selected algorithms and software modules will be installed, tested and integrated into NRL's EM modeling effort using a sun workstation network. The models will become part of the Navy low frequency EM modeling capability. NRL will manage project and select algorithms for integration.

WORK COMPLETED

The University of Utah consortium has made a number of accomplishments during the previous year. A group of nine graduate students and four professors have produced eighteen papers detailing the results of new methods in EM model development. New model developments have included:

- A fast imaging code for time domain electromagnetic interpretation
- A 2-D forward modeling and regularized weighting inversion for MT and CSMT data
- An improved accuracy 3-D EM forward modeling capability based on the quasi-linear approximation
- A 3-D EM inversion capability based on the quasi-linear approximation technique
- A 3-D visualization package for forward and inverse modeling solutions

Mississippi State University has developed a multi-parameter EM inversion technique to interpret sub-bottom electrical structure utilizing a multi-computer platform computational procedure to speed up calculations. The capability links several remote CPU processors to solve the inversion problem simultaneously. The inversion technique is based on a layered forward solution technique.

RESULTS

The University of Utah consortium has made a number of accomplishments during the previous year. A group of nine graduate students and four professors have produced eighteen papers detailing the results of new methods in EM model development.

IMPACT/APPLICATION

This work is focused on improving the Navy's EM forward modeling and data interpretation capability in a cost effective manner using academic resources and leveraging industry and other agency development efforts. Application of these numerical techniques have been used to relate the sea bottom electrical properties to the local sediment distributions and the influence these factors have on MCM operations. The connection between the sediment properties and the resulting MCM environmental parameters is poorly understood. Also these models are being used in work to determine the effects of multiple influence systems for ASW applications.

TRANSITIONS

Models from this work have been transitioned to the NRL Multiple-Influence Detection task and in the ONR sponsored work in Environmental Characterization For EM Techniques in MCM.

RELATED PROJECTS

Related projects include the NRL Multiple-Influence Detection task, which has investigated the effects of the environment on data fusion of different sensor types for ASW applications.

PUBLICATIONS

Nikolay Golubev and Michael S. Zhdanov , 1998, Comparative Study of Land and Sea Bottom Geoelectric Anomalies: SEG New Orleans, 1998.

Michael S. Zhdanov and Ge Zhang, 1998, Finite Functions Method in the Solution of 3-D Electromagnetic Inverse Problems : SEG New Orleans, 1998.

Michael S. Zhdanov, Sheng Fang, and Ge Zhang , 1998, Accuracy Estimation and Model Study of the Quasi-Linear Series Method of 3-D Electromagnetic Modeling : SEG New Orleans, 1998.